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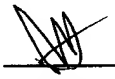
SIGNATURE : 

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COMMISSIONER

[ABSTRACT OF THE DISCLOSURE]

[ABSTRACT]

Disclosed is a method for determining a paging alert mode of a mobile terminal in a mobile communication system. The mobile terminal determines whether there exists a sub-BSC, depending on a broadcasting channel message provided form a main BSC. When the sub-BSC exists, the mobile terminal monitors receipt of a beacon paging group frame from the sub-BSC, and upon receipt of the beacon paging group frame, changes the paging alert mode to a predetermined paging alert mode.

[SPECIFICATION]

[TITLE OF THE INVENTION]

APPARATUS AND METHOD FOR DETERMINING PAGING ALERT MODE IN A MOBILE COMMUNICATION SYSTEM

[BRIEF DESCRIPTION OF THE DRAWINGS]

FIG. 1 is a diagram illustrating a conceptional cell structure of a general mobile communication system;

FIG. 2 is a diagram illustrating a structure of a paging message using a conventional super frame;

FIG. 3 is a diagram illustrating the relationship between a general paging group and a physical channel;

FIG. 4 is a diagram illustrating a conceptional cell structure of a mobile communication system according to an embodiment of the present invention;

FIG. 5 is a diagram illustrating a structure of a super frame including a beacon paging group according to an embodiment of the present invention;

FIG. 6 is a block diagram illustrating a structure of a main BSC according to an embodiment of the present invention;

FIG. 7 is a flow chart illustrating a procedure for generating a broadcasting channel (BCH) message in a main BSC according to an embodiment of the present invention;

FIG. 8 is a flow chart illustrating a procedure for transmitting a paging group frame in response to a paging request in a radio network controller (RNC) according to an embodiment of the present invention;

FIG. 9 is a flow chart illustrating a procedure for generating a physical channel message in a sub-BSC according to an embodiment of the present invention;

FIG. 10 is a block diagram illustrating a structure of a mobile terminal according to an embodiment of the present invention;

FIG. 11 is a flow chart illustrating a procedure for determining a paging alert mode in a mobile terminal according to an embodiment of the present invention; and

FIG. 12 is a flow chart illustrating a procedure for performing a paging alert mode in a mobile terminal according to an embodiment of the present invention.

[DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT]
[OBJECT OF THE INVENTION]
[RELATED FIELD AND PRIOR ART OF THE INVENTION]

The present invention relates generally to an apparatus and method for determining a paging alert mode in a mobile communication system, and in particular, to an apparatus and method for determining a paging alert mode of a mobile terminal in a base station controller (BSC).

A rapid growth of the mobile communication business has caused a rapid increase in population of the mobile subscribers. Further, as the population of the mobile subscribers increases rapidly, the mobile communication service providers are competing against each other to attract many subscribers by providing the services differentiated from those of other mobile communication service providers.

FIG. 1 illustrates a conceptional cell structure of a conventional mobile communication system, in which one cell 20 is formed by its associated base station controller (BSC) 30.

A paging operation of the conventional mobile communication system will be described with reference to the above cell structure. Upon receipt of a paging request from a core network (CN), a radio network controller (RNC) 10 determines a paging-requested mobile terminal. After determining the paging-requested mobile terminal, the RNC 10 calculates a paging group to which the mobile terminal belongs, using an identification (ID) of the paging-requested mobile terminal. Calculation of the paging group is

accomplished by mapping the ID of the mobile terminal to a given mapping group. At this point, all the mobile terminals within the cell are uniformly distributed to the paging groups constituting a super frame. FIG. 2 illustrates a structure of the super frame required for the paging operation in the conventional mobile communication system. As illustrated in FIG. 2, the super frame used in the conventional mobile communication system is comprised of a specified number (e.g., 288 in FIG. 2) of paging group frames. Therefore, uniform distribution refers to uniformly matching the number of the mobile terminals belonging to the respective paging group frames.

Meanwhile, after completing calculation of the paging group to which the paging-requested mobile terminal belongs, the RNC 10 creates a paging group frame corresponding to the paging group calculated to page the corresponding mobile terminal, out of the paging frame groups constituting the super frame. The paging group frame is created such that it should have paging information for paging a specific mobile terminal, and a message format of the paging group frame is illustrated in FIG. 3. Referring to FIG. 3, one paging group frame is comprised of 4 slots, and divided into 6 sub-items in total. Here, one slot is 0.625ms, and comprised of pilot and data. The 6 sub-items constituting the paging group frame include a first paging indicator bit PI1, a second paging indicator bit PI2, and 4 mobile user IDs MUI1-MUI4. For example, when paging occurs, the PI1 and PI2 fields are set to a value of multiple bits of '1', and when paging does not occur, the PI1 and PI2 fields are set to a value of multiple bits of '0'. In the following description, the information bits stored in the PI1 and PI2 files, and the MUI1-MUI4 fields will be referred to as paging information. Further, the above-stated each sub-item is distributed in 4-slot unit. Therefore, the 288^{th} one of the paging group frames constituting the super frame starts from the 1149^{th} (=2874+1) slot constituting a physical channel. When the paging group frame with the above structure is created, the RNC 10 distributedly inserts the respective paging information shown in FIG. 3 in a designated one of the slots constituting the physical channel, and provides it to a BSC 30. Shown in FIG. 3 is the structure of a physical channel in which PI1 is inserted in the 1149^{th} slot, PI2 in the 1152^{nd} slot, MUI1 in the 3^{rd} slot, and MUI2 in the 8^{th} slot.

Meanwhile, the BSC 30 to which such structured slots are to be transmitted is a BSC for forming a cell 20 in which the mobile terminal is located. This is determined depending on the mobile terminal's position information managed by the network. Upon receipt of the paging information, the BSC 30 transmits the received paging information to all the mobile terminals located in the corresponding cell 20 through the physical channel.

Upon power-on, the corresponding mobile terminal calculates a paging group to which it belongs, using its mobile ID. Calculation of the paging group is accomplished by the same method as that used in the BSC to calculate the paging group using the mobile ID. After that, the mobile terminal proceeds to a suspended mode, and turns on radio frequency receive power (RF Rx power) at a slot assigned for the calculated paging group out of the slots constituting the physical channel, to determine whether there exists paging. That is, all the mobile terminals located in the cell 20 continuously monitor the paging information corresponding to the paging groups to which they belong. That the mobile terminal continuously monitors its paging information means that the mobile terminal is enabled at a time when the corresponding slot of the physical channel over which the paging information of its paging group is transmitted, to read all the information loaded in the slot. At this point, the first read paging information is the bit value stored in the PI1 field of the paging group, and it is possible detect existence of paging by reading this bit value. Since the PI1 and PI2 are not channel-coded, existence/nonexistence of paging is determined in a physical layer (L1) of the mobile terminal by checking the number of the PI bits with logic '1'. If existence of paging is detected by the PI1 bit value, the mobile terminal determines whether it is paged by monitoring the MUI1-MUI4 fields after detecting existence of paging through the PI2 bit value. When the mobile terminal recognizes that it is paged by monitoring the MUI1-MIU4 fields, the mobile terminal generates an alert tone in a paging alert mode set by the subscriber. The alert mode set by the mobile terminal can be divided into a melody mode in which paging is indicated using a melody, a vibration mode in which paging is indicated by vibration, and a mute mode in which paging is

indicated through a display. As mention above, such an alert mode can be set by only the subscriber's manipulating the mobile terminal in person.

As described above, when paging occurs for a specific mobile terminal, the RNC and the BSC of the conventional mobile communication system service only the function of simply paging the corresponding mobile terminal through the physical channel. That is, the conventional mobile communication system controls only the radio communication service but cannot control the function of changing the paging alert mode provided in the mobile terminal. Accordingly, in order to change the paging alert mode according to the surroundings, the subscriber should change the mode by manipulating the keypad prepared in the mobile terminal in person, suffering inconveniences.

[SUBSTANTIAL MATTER OF THE INVENTION]

It is, therefore, an object of the present invention to provide a method for setting a paging alert mode in a mobile communication system.

It is another object of the present invention to provide a method for setting a paging alert mode of a mobile terminal under the control of a BSC (Base Station Controller) according to a position of the mobile terminal in a mobile communication system.

It is further another object of the present invention to provide a method for setting a paging alert mode of a mobile terminal located in a sub-cell in a mobile communication system.

It is yet another object of the present invention to provide a method for setting a paging alert mode of a mobile terminal under the control of a BSC in a mobile communication system.

To achieve the above and other objects, a BSC of a mobile communication system informs a mobile terminal that the cell to which the

mobile terminal is presently located includes a sub-cell. The mobile terminal periodically examines a beacon paging group provided form the sub-cell, and upon detecting the beacon paging group, sets a silent paging alert mode.

In accordance with one aspect of the present invention, there is provided a method for determining a paging alert mode of a mobile terminal in a mobile communication system. The mobile terminal determines whether there exists a sub-BSC, depending on a broadcasting channel message provided form a main BSC. When the sub-BSC exists, the mobile terminal monitors receipt of a beacon paging group frame from the sub-BSC, and upon receipt of the beacon paging group frame, changes the paging alert mode to a predetermined paging alert mode.

In accordance with another aspect of the present invention, there is provided a method for determining a paging alert mode in a mobile communication system. A main BSC inserts sub-cell information for a sub-cell and a beacon paging period in a broadcasting channel message and transmitting the broadcasting channel message, when the sub-cell exists in a main cell formed by the main BSC. Upon receipt of a paging request from a core network, a radio network controller transmits paging request information with a paging group frame to which a paging-requested mobile terminal belongs, out of paging group frames in a super frame. A sub-BSC forms the sub-cell and transmits a beacon paging group frame requesting a change of the paging alert mode in sync with the paging group frames.

In accordance with further another aspect of the present invention, there is provided an apparatus for determining a paging alert mode in a mobile communication system. In the apparatus, a main BSC for forms a main cell, and inserts, when there exists a sub-cell in the main cell, sub-cell information for the sub-cell and a beacon paging period in a broadcasting channel message before transmission. A radio network controller transmits paging request information with the paging group frame to which a paging-requested mobile terminal belongs, out of the paging group frames in the super frame. A sub-BSC forms the

sub-cell, and transmits a beacon paging group frame requesting a change of the paging alert mode in response to an interrupt from the radio network controller. A mobile terminal sets the paging alert mode according to whether the beacon paging group frame is accessed, and performs the set paging alert mode when paging is detected by accessing the paging group frame.

[CONSTRUCTION AND OPERATION OF THE INVENTION]

A preferred embodiment of the present invention will be described herein below with reference to the accompanying drawings. In the following description, well-known functions or constructions are not described in detail since they would obscure the invention in unnecessary detail.

Although the term node B is used in an UMTS (Universal Mobile Telecommunication System) system which forms asynchronous main cell and sub-cell which are necessary elements in implementing the present invention, the term base station controller (BSC) will be used for the same meaning in the following description.

FIG. 4 illustrates a conceptional cell structure of a mobile communication system for proposing a paging alert mode according to an embodiment of the present invention. As illustrated in FIG. 4, an exemplary embodiment of the present invention has a fundamental cell structure in which a sub-cell 70 is formed within a main cell 50. Thus, the embodiment separately includes a main BSC 60 for forming the main cell 50 and a sub-BSC 80 for forming the sub-cell 70. The main BSC 60 located in the main cell 50 and the sub-BSC 80 located in the sub-cell 70 are controlled by a radio network controller (RNC) 40.

Now, a detailed description of the embodiment will be made with reference to FIG. 4.

The main BSC 60 has the function of processing various messages transmitted and received over the corresponding channel to implement the radio

communication service with the mobile terminals located in the main cell 50. In particular, the main BSC 60 transmits a broadcasting channel (BCH) message to all the mobile terminals in the main cell 50 at stated periods in order to implement the present invention. Here, the broadcasting channel message being transmitted at stated periods refers to the message transmitted by the broadcasting channel commonly used in the mobile communication system. The channel which can be used as the broadcasting channel includes a channel over which the main BSC 60 can simultaneously transmit a message to all the mobile terminals within the main cell 50. Meantime, the message transmitted by the broadcasting channel includes system information. The system information is comprised of various IDs (e.g., present network ID, location ID and cell ID), all the information to be used in measuring a candidate cell for handover and cell selection, information about the control channel in the present cell, information for controlling use of a random access channel (RACH), protocol information, and additional information required for implementation of the present invention. The additional information is comprised of a beacon paging period and sub-cell information including beacon paging group ID as information for defining the different specifications supported in the cell. The sub-cell information designates a beacon paging group according to existence of the sub-cell in the main cell 50 where the mobile terminal is presently located. The beacon paging period is a period for which a beacon paging group frame is generated by the sub-cell. The operation of the main BSC 60 for generating the broadcasting channel message and transmitting the generated message is performed according to the procedure shown in FIG. 7, which will be described later. In addition, the main BSC 60 transmits the paging group frames provided from the RNC 40 to the mobile terminals in the main cell 50 over the physical channel. The paging group frames being transmitted over the physical channel constitute a super frame, an exemplary structure of which is shown in FIG. 5. A detailed description of the structure will be given later.

In the sub-BSC 80, there exists only the physical channel and the beacon paging group frames being transmitted over the physical channel are delivered only to the mobile terminals located in the sub-cell 70. Here, the beacon paging

group frames are transmitted in sync with the paging group frame being transmitted over the physical channel in the main BSC 60. The operation of transmitting the beacon paging group frames by the sub-BSC 80 is performed according to the procedure shown in FIG. 9, which will be described later. The structure of the beacon paging group frame is comprised of the beacon paging group information. The beacon paging group refers to paging groups assigned to the sub-cell 70. The beacon paging group information is information to be inserted in the beacon paging group frames and is information for informing the mobile terminal that it is presently located in the sub-cell 70. The structure of the beacon paging group information is identical to the structure of the common paging group frame shown in FIG. 3, and the timing for which the beacon paging group frames are transmitted is shown in FIG. 5. The detailed structure of the beacon paging group frames will be described later.

The RNC 40 generates a paging message in response to a paging request from a core network (NC), and provides the generated paging message to the main BSC 60, to transmit the paging message to the mobile terminals located in the main cell 50. The paging message generated by the RNC 40 constitutes a super frame, and the super frame is comprised of a plurality of paging group frames. The paging group frames correspond to their associated paging groups, and assignment of the paging groups is performed according to the mobile terminals. That is, every mobile terminal has its associated paging group to which it belongs, and the paging group is determined according to each mobile ID and the number of the paging group frames constituting the super frame. Further, the RNC 40 creates a different super frame according to whether the main BSC 60 includes the sub-BSC 80. That is, when the sub-BSC 80 does not exist, all the frames for constituting the super frame are assigned as paging group frames. However, when the sub-BSC 80 exists, only the frames excepting the beacon paging group frames assigned to the sub-BSC 80 are assigned as the paging group frames. Here, the beacon paging group frames are created by the sub-BSC 80 as mentioned above, and the RNC 40 generates an interrupt for allowing the sub-BSC 80 to generate the beacon paging group frames in sync with the super frame created by it. An exemplary structure of the super frame

created by the RNC 40 is shown in FIG. 5. As can be understood from FIG. 5, although the super frame can be comprised of 288 frames in total, the number of frames which can be used for the pure paging group frames is 287, since the 288th frame is assigned as a beacon paging group frame because of existence of the sub-BSC 80. At this point, the RNC 40 generates an interrupt at the time point where the 288th paging group frame is generated to allow the 288th beacon paging group frame from the sub-BSC 80 to be synchronized with the super frame created by it, so that the sub-BSC 80 generates the beacon paging group frame.

As described above, in an embodiment of the invention, the common paging group frames are transmitted from the main BSC 60, and only one frame designated as the beacon paging group frame is transmitted from the sub-BSC 80. Therefore, in the embodiment of the present invention, it is necessary to accurately synchronize the frames transmitted from the main BSC 60 with the frame transmitted from the sub-BSC 80. The reason is to enable the mobile terminal to receive the paging group frames transmitted from the main BSC 60 and the beacon paging group frame transmitted from the sub-BSC 80 as one super frame. For example, if it is assumed that the super frame is comprised of 288 frames and the 288th frame is designated as the beacon paging group frame, the sub-BSC 80 will transmit the beacon paging group frame at the time point where the main BSC 60 completes transmission of the 287 paging group frames, as shown in FIG. 5. Here, the timing between the main BSC 60 and the sub-BSC 80 can be set through wire or wireless connection. For example, the main BSC 60 provides the sub-BSC 80 with the transmission period of the beacon paging group frame against the super frame transmission period so that the sub-BSC 80 can synchronously transmit the beacon paging group frame, or the main BSC 60 indicates the time point to transmit the beacon paging group frame through interrupt. However, it is not possible to guarantee exact synchronization even though synchronization is achieved as stated above. Therefore, it is possible to prevent the beacon paging group frame from being interfered with neighbor frames, by preventing the main BSC 60 from using the previous and next frames of the frame designated as the beacon paging group frame. Although the beacon

paging group frame is limited to the 288th group in FIG. 5, it will be understood by those skilled in the art that it is possible to designate at least one unspecified frame out of the frames constituting the super frame as the beacon paging group frame.

The present invention should include the following operations in order to change the paging alert mode of a mobile terminal in the BSC.

First, the main BSC 60 should include an operation of transmitting the beacon paging group information based on existence of the sub-cell 70 to all the mobile terminals located in the main cell 50 through the broadcasting channel.

Second, the RNC 40 should include an operation of transmitting the super frame comprised of the paging group frames to the mobile terminals located in the main cell 50 through the main BSC 60 in response to a paging request.

Third, the sub-BSC 80 should include an operation of transmitting the beacon paging group frame to the mobile terminals located in the sub-cell 70 in response to the paging request.

Fourth, the mobile terminals should include an operation of setting the paging alert mode by examining the beacon paging group frame provided from the sub-BSC 80 based on the beacon paging group information provided from the main BSC 60 over the broadcasting channel.

Fifth, the mobile terminals should include an operation of examining a paging group frame transmitted from the RNC 40 through the main BSC 60 and indicating, upon detecting paging information, occurrence of paging by the set paging alert mode.

Now, a detailed description will be made of the operations required in the invention with reference to the accompanying drawings. In the following description, the operations will be divided into an operation performed by the

main BSC 60, the sub-BSC 80 and the RNC 40, and an operation performed by the mobile terminals.

First, the above-stated first to third required operations will be described in detail with reference to the structure of the main BSC 60 and the sub-BSC 80 according to an embodiment of the present invention.

The structures of the main BSC 60 and the sub-BSC 80 according to an embodiment of the present invention are shown in FIG. 6. The main BSC 60 and the sub-BSC 80 have the same hardware structure. Therefore, in describing the structure of FIG. 6, the main BSC 60 and the sub-BSC 80 will both be called BSC.

Referring to FIG. 6, the structure of the BSC will be described. A controller 110 controls the overall operation of the BSC. In particular, the controller 110 performs an overall control operation of generating a broadcasting channel message and transmitting the generated broadcasting channel message over the broadcasting channel for implementing the invention. Further, the controller performs a control operation of transmitting the super frame comprised of the paging group frames provided from the RNC 40.

First Required Operation

With reference to FIG. 7, a detailed description will be made regarding an operation of transmitting the broadcasting channel message, which corresponds to the above-stated first required operation.

The main BSC 60 determines in step 210 whether there is any sub-cell 70 existing within the main cell 50. Existence of the sub-cell 70 means that there exists a location within the main cell 50, where the paging alert tone should be restricted, such as a public performance hall and a public conference room. If it is determined in step 210 that there does not exist the sub-cell 70, the main BSC 60 proceeds to step 216 and generates a common broadcasting channel (BCH)

message. The common broadcasting channel message is used to transmit mobile communication system information required for radio communication to all the mobile terminals within the cell at stated periods. The mobile communication system information transmitted through the broadcasting channel message is comprised, as stated above, of various IDs (e.g., present network ID, location ID and cell ID), all the information to be used in measuring a candidate cell for handover and cell selection, information about the control channel in the present cell, information for controlling use of a random access channel (RACH) and protocol information. The broadcasting channel message has not been specified by the present standard of the future mobile communication system, and the broadcasting channel message used in the invention can be implemented for any future standard structure.

Otherwise, if it is determined in step 210 that the sub-cell 70 exists, the main BSC 60 sets a paging group for the sub-cell 70 in step 212. The paging group for the sub-cell 70 means a beacon paging group, and the paging group is set by designating at least one of the paging group frames constituting the super frame to be transmitted. After setting the beacon paging group in step 212, the main BSC 60 proceeds step 214 where the main BSC 60 generates a broadcasting channel (BCH) message by inserting the additional information required for implementing the present invention in the information constituting the common broadcasting channel message. The additional information required for implementing the present invention includes sub-cell information with a beacon paging group ID and a beacon paging period, and the additional information can be determined by the beacon paging group set in step 212. In addition, the beacon paging period can be set to be equal to a transmission period of the super frame, or can be set to a multiple of the transmission period of the super frame.

Meantime, after completing generation of the broadcasting channel message in step 216 or 214, the main BSC 60 transmits the generated broadcasting channel message to all the mobile terminals located in the main cell

50, in step 218. Transmission of the broadcasting channel message can be performed at predefined periods or at the request of the upper layer.

Second Required Operation

With reference to FIG. 8, a detailed description will be made regarding an operation in which the RNC 40 transmits the paging group frames to all the mobile terminals located in the main cell 50 through the main BSC 60 in response to a paging request. This operation corresponds to the above-stated second required operation.

The RNC 40 monitors in step 310 whether a paging request for paging a specific mobile terminal is generated from the core network which is the upper layer. Upon detecting the paging request in step 310, the RNC 40 examines, in step 312, the cell in which the paged mobile terminal is presently located and determines whether there exists a sub-cell taking the examined cell as a main cell. That is, it is determined whether there exists the sub-cell 70 formed by the sub-BSC 80 within the main cell 50 formed by the main BSC 60, as shown in FIG. 4. As one method for determining existence of the sub-cell 70, the RNC 40 can manage information about its BSC using a table and determine existence of the sub-cell by searching the table. Although there are several different methods, the detailed description will be avoided herein. The RNC 40 determines in step 314 whether there exists the sub-cell 70, based on the examination performed in step 312. If it is determined in step 314 that there does not exist the sub-cell 70, the RNC 40 designates a common paging group using an ID of mobile terminal to be paged, in step 316. Commonly, an ID of the mobile terminal to be paged and the number of the paging groups constituting the super frame should be determined to designate the paging group. The reason is to enable all the mobile terminals belonging to the RNC 40 to be evenly distributed to the respective paging groups according to the number of the paging groups constituting the super frame. In step 316, since the beacon paging group is not assigned, the paging group is determined using the number of all the frames constituting the super frame.

Otherwise, if it is determined in step 314 that the sub-cell 70 exists, the RNC 40 proceeds to step 318. In step 318, the RNC 40 designates a paging group to which the mobile terminal belongs, by using the number of the paging groups excepting the beacon paging group out of the paging groups constituting the super frame and an ID of the paged mobile terminal.

Meanwhile, after determining the paging group to which the mobile terminal belongs in steps 316 and 318, the RNC 40 assembles a paging message according to the determined paging group in step 320. The paging message is assembled in the form of the above-described super frame, and the number of the paging group frames constituting the super frame is determined according to existence/nonexistence of the sub-cell 70. That is, when the sub-cell 70 does not exist, all the frames constituting the super frame are used for the paging group frame, and otherwise, when the sub-cell 70 exists, the frames excepting the frame designated as the beacon paging group frame out of all the frames constituting the super frame are used for the paging group frame. For example, assume that the super frame is comprised of 288 frames and the beacon paging group frame is comprised of one frame, as shown in FIG. 5. In this case, if the sub-cell 70 does not exist, the paging message created in step 320 will become a super frame comprised of 288 paging group frames. Otherwise, if the sub-cell 70 exists, the paging message created in step 320 will become a super frame comprised of 287 paging group frames. In addition, in order to create the super frame corresponding to the paging message, it is necessary to insert information indicating paging in a paging group frame corresponding to the determined paging group out of the paging group frames constituting the super frame. The structure of the paging group frame in which the information indicating paging is inserted is equal to that described with reference to FIG. 3. That is, when paging occurs, the PI1 and PI2 bit values of the paging group frame to which the paged mobile terminal belongs are all set to '1', and the MUI1-MUI4 are filled with the information designating the paged mobile terminal.

After completing generation of the paging message in step 320, the RNC 40 transmits the generated paging message to the BSC corresponding to the cell where the mobile terminal to be paged is located, in step 322. The BSC where the mobile terminal is located is determined according to position information of the mobile terminal, managed by the network. Meanwhile, upon receipt of the paging message from the RNC 40, the BSC transmits the received paging message to all the mobile terminals within the cell through the physical channel.

Third Required Operation

With reference to FIG. 9, a detailed description will be made regarding an operation in which the sub-BSC 80 transmits the beacon paging group frame to the mobile terminals located in the sub-cell 70 in response to a paging request. This operation corresponds to the above-stated third required operation.

The sub-BSC 80 determines in step 412 whether a transmission time point of the beacon paging group frame has arrived. A method for determining whether the transmission time point of the beacon paging group frame has arrived is divided into one method for carrying out the determination in response to an enable request from the RNC 40, and another method for previously receiving information required for determining the transmission time point, i.e., a beacon paging group frame generation period and determining whether the period has arrived. When using the former method for determining arrival of the transmission time point upon receipt of the enable request from the RNC 40, it is most important to synchronize the transmission time point with the paging group frame generated from the RNC 40. In other words, the beacon paging group frame should be exactly created in a region to which the beacon paging group frame out of the frames constituting the super frame is assigned, as stated above. Therefore, there have been proposed several methods for synchronizing the RNC 40 with the sub-BSC 80, and the typical method can be divided into a wire synchronization method and a wireless synchronization method.

The sub-BSC 80 determines in step 414 whether the designated transmission time point has arrived, based on the monitoring result of step 412. If it is determined in step 414 that the designated transmission time point has not arrived, the sub-BSC 80 returns to step 412 and continuously monitors arrival of the designated transmission time point. Otherwise, if it is determined in step 414 that the designated transmission time point has arrived, the sub-BSC 80 generates a paging message in step 416. The paging message generated from the sub-BSC 80 has a message format in which all the frames excepting the beacon paging group frame are not generated out of the frames constituting the super frame and only the beacon paging group frame is generated. That is, the sub-BSC 80 bocks transmission in other frames excepting the beacon paging group frame, so as not to influence the paging group frames constituting the paging message transmitted from the main BSC 60. The beacon paging group frame is equal in structure to the common frame shown in FIG. 3, but they are different from each other in information recorded therein. For example, the PI1, PI2, MUI1, MUI2, MUI3 and MUI4 bits, shown in FIG. 3, constituting the frame are all set to '1'. After completing generation of the beacon paging group frame in step 416, the sub-BSC 80 transmits the paging message having the generated beacon paging group frame to the mobile terminals located in the sub-cell 70, in step 418.

According to the description of the above-stated first to third required operations, the broadcasting channel message and the paging message transmitted from the main BSC 60 can be received at every mobile terminal located in the main cell 50, and the paging message including the beacon paging group frame transmitted from the sub-BSC 80 can be received at only the mobile terminals which are located in both the sub-cell 70 and the main cell 50. This can be realized by controlling transmission power of the sub-BSC 80 which forms the sub-cell 70. Accordingly, when paging occurs, the mobile terminal can receive or cannot receive the beacon paging group frame according to whether it is located in the sub-cell 70, thereby providing an improved service.

The embodiment of the present invention proposes a scheme for switching a paging alert mode of the mobile terminal using the improved service. That is, when the mobile terminal is located in a position where it cannot receive the beacon paging group frame, the mobile terminal operates in the alert mode set by the subscriber, and otherwise, when the mobile terminal is located in a position where it can receive the beacon paging group frame, the mobile terminal operates in the mute mode in which paging is alerted silently.

Next, a detailed description will be made regarding the above-stated fourth and fifth operations together with the structure for switching the paging alert mode of the mobile terminal using the improved service.

A structure of the mobile terminal according to an embodiment of the present invention is illustrated in FIG. 10. Referring to FIG. 10, the structure of the mobile terminal will be described in detail. A controller 510 controls the overall operation of the mobile terminal. In particular, the controller 510 performs the overall control operation of automatically switching the paging alert mode according to whether the beacon paging group frame is received or not. The control procedure performed by the controller 510 to implement the present invention is illustrated in FIGS. 11 and 12, and the detailed description of it will be given later. An RF module 512 has the function of transmitting and receiving information through a wireless network. Although the information transmitted and received through the wireless network is various, the information mentioned in the invention is limited to the broadcasting channel message and the paging message. A baseband analog processor 514 converts a signal received through the RF module 512 to a baseband analog signal. A modem 516 analyzes information provided from the baseband analog processor 514 and provides the analyzed information to the controller 510. In particular, the modem 516 analyzes sub-cell information and a beacon paging period from the broadcasting channel message received through the baseband analog processor 514 and provides the analyzed results to the controller 510. Further, the modem 516 accesses the paging group frame corresponding to the paging group to which the mobile terminal belongs and the designated beacon paging group frame from the

paging message received through the baseband analog processor 514, analyzes various information inserted in the accessed paging group frame and beacon paging group frame, and then provides the analyzed results to the controller 510. A memory 518 stores a control algorithm required to control the mobile terminal in the controller 510 and various information required to control the mobile terminal. A vibrator 520, if the paging alert mode is set to a vibration mode at a time point when paging occurs, generates vibration for indicating receipt of an incoming call under the control of the controller 510. A display 522 displays the present status of the mobile terminal under the control of the controller 510. In particular, when the paging alert mode is switched by the message received from the BSC, the display 522 displays a message for informing the subscriber of a change of the alert mode under the control of the controller 510. A keypad 524 being a combination of keys operable by the subscriber, generates key data corresponding to a key operation of the subscriber and provides the generated key data to the controller 510. A ring generator 526 generates various rings upon detection of paging under the control of the controller 510. Meanwhile, the ring generator 526 generates the ring upon detection of paging, only when the paging alert mode is set to a bell mode.

Fourth Required Operation

With reference to FIG. 11, a detailed description will be made regarding an operation of setting the paging alert mode by examining the beacon paging group frame based on the beacon paging group information received through the broadcasting channel. This operation corresponds to the above-stated fourth required operation.

The mobile terminal determines in step 610 whether a broadcasting channel message is received or not. The broadcasting channel message is generated by the main BSC 60 and transmitted over the broadcasting channel, and includes the sub-cell information and the beacon paging period, as stated above. Upon receipt of the broadcasting channel message in step 610, the mobile terminal analyzes the sub-cell information and the beacon paging period

included in the received broadcasting channel message in step 612. After completing the analysis, the mobile terminal temporarily stores the analyzed sub-cell information and beacon paging period and then proceeds to step 614 to determine whether the cell to which it presently belongs includes a sub-cell. Existence of the sub-cell is determined according to the sub-cell information and the beacon paging period analyzed in step 612. That the broadcasting channel message includes the sub-cell information and the beacon paging period means that there exists a sub-cell. Otherwise, that the broadcasting channel message does not include the sub-cell information and the beacon paging period means that there exists no sub-cell.

If it is determined in step 614 that the sub-cell 70 does not exist, the mobile terminal proceeds to step 616 and determines a paging group to which it belongs, depending on its mobile ID and the number (e.g., 288) of paging groups for the case where the sub-cell 70 does not exist. Otherwise, if it is determined in step 614 that the sub-cell 70 exists, the mobile terminal proceeds to step 618 and determines a paging group to which it belongs, depending on its mobile ID and the number (e.g., 287) of the paging groups used for actual paging excepting the beacon paging group.

Meantime, after determining the paging group to which it belongs in step 618, the mobile terminal proceeds to step 620 and accesses a beacon paging group frame out of the paging group frames constituting the paging message transmitted from the BSCs 60 and 80 over the physical channel in the beacon paging period. At this point, the mobile terminal accesses not only the beacon paging group frame but also the paging group frame determined in step 618. Accessing the paging group frame is to detect the information for paging the mobile terminal, and an operation of accessing the paging group frame will be descried later with reference to FIG. 12. Accessing the beacon paging group frame in the beacon paging period analyzed in step 612 from the broadcasting channel message should be performed on the assumption that the mobile terminal is frame-synchronized with the BSCs 60 and 80. Meanwhile, upon receipt of the beacon paging group frame through an access of the beacon paging

group frame in step 620, the mobile terminal analyzes the beacon paging group information constituting the beacon paging group frame, i.e., the PI1, PI2, MUI1, MUI2, MUI3 and MUI4 bit values. After analyzing the beacon paging group information, the mobile terminal determines in step 622 whether a change of the paging alert mode is requested, depending on the analyzed beacon paging group information. The paging alert mode change request is determined by the bit values constituting the beacon paging group frame. For example, it is determined whether the mobile terminal is presently located in the sub-cell 70, by examining the number of the bits having a bit value '1' out of the PI and MUI bits constituting the beacon paging group frame. Such determination is available because the beacon paging group frame transmitted from the sub-BSC 80 forming the sub-cell 70 is received only at the mobile terminals located in the sub-cell 70. Therefore, when the mobile terminal is not located in the sub-cell 70, it cannot receive the beacon paging group frame transmitted from the sub-BSC 80, thus judging that there is no paging alert mode change request.

If it is determined in step 622 that the paging alert mode change request is received, the mobile terminal changes the present paging alert mode to a mute paging alert mode in step 624. Changing the paging alert mode means that the subscriber of the mobile terminal stays in a place that requires silence. In addition, an operation of changing the paging alert mode by software is already supported by the mobile terminals, so that no additional structure is required for this operation.

Otherwise, if it is determined in step 622 that the paging alert mode change request is not received, the mobile terminal proceeds to step 626 and changes the paging alert mode to a paging alert mode set by the user, i.e., the subscriber of the mobile terminal. The operation of changing the paging alert mode to a paging alert mode set by the subscriber is also commonly supported by the mobile terminal as in the operation of step 624, so that no additional structure is required for this operation.

In addition, though not shown in the drawing, when the paging alert mode is changed in step 624 and 626, the mobile terminal displays on the display 522 a message informing the subscriber of a change of the paging alert mode.

In the forgoing description, the paging alert mode change request is limitedly used to change the paging alert mode to the silent (or mute) alert mode. However, the paging alert mode change request can also be used to maintain the silent alert mode or change the paging alert mode to an alert mode set by the user in a situation where the alert mode of the mobile terminal is already set to the silent alert mode. That is, the paging alert mode change request should not be construed as only a meaning of changing the paging alert mode of the mobile terminal located in the sub-cell 70, and should also include a meaning of changing the paging alert mode for the case where the mobile terminal located in the sub-cell 70 moves out of the sub-cell 70. In addition, the silent paging alert mode includes the vibration mode and other alert modes in which alert tone such as a melody is not generated.

Fifth Required Operation

Finally, with reference to FIG. 12, a detailed description will be made regarding an operation of alerting paging based on the paging information by examining the paging group frame provided through the physical channel. This operation corresponds to the above-stated fifth required operation. The operation described below is performed after determining the paging group to which the mobile terminal belongs, in steps 616 and 618 of FIG. 11. The operation of FIG. 12 will be described on the assumption that the paging group to which the mobile terminal belongs is already determined.

In step 710, the mobile terminal accesses the paging group frame corresponding to the previously determined paging group. The paging group frame is a frame designated by the determined paging group out of the paging group frames constituting the super frame transmitted from the RNC 40 through the main BSC 60, and is comprised of PI and MUI as stated above. After

accessing the corresponding paging group frame in step 710, the mobile terminal analyzes the PI bit values of the accessed paging group frame in step 712. Analyzing the PI bit values is to determine whether there is an incoming call to the paging group to which the mobile terminal belongs. After completing the analysis of the PI bit values in step 712, the mobile terminal determines in step 714 whether there is a paging request, based on the analyzed PI bit values. For example, when the PI bits have the values of '1', the mobile terminal determines that there is a paging request. Otherwise, the mobile terminal determines that there is no paging request. If it is determine in step 714 that there is no paging request, the mobile terminal accesses again the frame of paging group to which it belongs out of the paging group frames constituting the super frame received in the next period and continuously determines whether there exists the paging request, through the above operation.

However, if it is determined in step 714 that there is the paging request, the mobile terminal analyzes the MUI of the accessed paging group in step 716. The MUI includes information for identifying the paged mobile terminal and in step 716, the information for identifying the mobile terminal inserted in the MUI is analyzed. After completing the analysis of the identification information of the mobile terminal in step 716, the mobile terminal determines in step 718 whether it is paged. Whether the mobile terminal is paged is determined by comparing the analyzed identification information of the mobile terminal with its identification information to see if they are identical to each other. For the identification information, a mobile ID can be used which is typically used to identify the mobile terminal.

If it is determined in step 718 that the paging request is for paging the mobile terminal, it performs the paging alert mode in step 720. As the mobile terminal performs the paging alert mode, the subscriber can answer the call by detecting the paging alert in the paging alert mode set in accordance with the operation of FIG. 11. Therefore, the mobile terminal can detect the incoming call by the improved paging alert mode according to the place where it is presently located.

[EFFECT OF THE INVENTION]

As described above, the invention informs the mobile terminal of existence of the sub-cell through the broadcasting channel, so that the mobile terminal examines the beacon paging group frame only when the sub-cell exists and determines its paging alert mode according to the examination result of the beacon paging group frame. Therefore, when the mobile terminal is located in a place such as a music hall and a public conference room where the alert tone of the mobile terminal should be restricted, the paging alert mode is automatically changed to the silent alert mode under the control of the BSC, thus contributing to convenience of the subscriber and preventing others from being troubled by the noisy alert tone.

[PATENT CLAIM(S)]

1. A method for determining a paging alert mode of a mobile terminal in a mobile communication system, comprising the steps of:

determining whether there exists a sub-BSC (Base Station Controller), depending on a broadcasting channel message provided form a main BSC;

monitoring receipt of a beacon paging group frame from the sub-BSC, when the sub-BSC exists; and

upon receipt of the beacon paging group frame, changing the paging alert mode to a predetermined paging alert mode.

2. The method as claimed in claim 1, where in the sub-BSC exists in a main cell being serviced by the main BSC.

3. The method as claimed in claim 2, wherein the broadcasting channel message is simultaneously transmitted to every mobile terminal located in the main cell by the main BSC.

4. The method as claimed in claim 1, wherein the paging alert mode changing step comprises the steps of:

upon receipt of the beacon paging group frame, judging that the mobile terminal is located in a sub-cell formed by the sub-BSC, and changing the paging alert mode to a silent paging alert mode; and

upon failure to receive the beacon paging group frame, judging that the mobile terminal is not located in the sub-cell, and changing the paging alert mode to a paging alert mode set by a subscriber.

5. The method as claimed in claim 4, wherein the silent paging alert mode is a vibration mode.

6. The method as claimed in claim 4, wherein the silent paging alert mode is a display mode.

7. The method as claimed in claim 4, wherein the beacon paging group frame is provided through a physical channel of the sub-cell.

8. A method for determining a paging alert mode of a mobile terminal in a mobile communication system, comprising the steps of:

receiving a broadcasting channel message from a main BSC;

analyzing sub-cell information and a beacon paging period from the broadcasting channel message;

determining whether a main cell formed by the main BSC includes a sub-cell, depending on the analysis result;

receiving, when the sub-cell exists, a beacon paging group frame provided from a sub-BSC of the sub-cell synchronized with the main cell in the beacon paging period;

upon receipt of the beacon paging group frame, setting the paging alert mode of the mobile terminal to a silent paging alert mode;

upon failure to receive the beacon paging group frame, setting the paging alert mode of the mobile terminal to a paging alert mode designated by a user;

calculating a paging group using an ID of the mobile terminal and the number of the paging group frames in the super frame provided form the main BSC through a physical channel;

accessing a paging group frame corresponding to the calculated paging group out of the paging group frames in the super frame; and

analyzing the accessed paging group frame, and upon detecting a paging request, indicating receipt of an incoming call by the set paging alert mode.

9. The method as claimed in claim 8, wherein the broadcasting channel message is simultaneously transmitted to every mobile terminal located in the main cell.

10. The method as claimed in claim 9, the silent paging alert mode is a vibration mode.

11. The method as claimed in claim 9, wherein the silent paging alert mode is a display mode.

12. The method as claimed in claim 10 or 11, wherein the beacon paging group frame is provided through a physical channel of the sub-cell.

13. The method as claimed in claim 8, wherein the number of the paging groups in the super frame provided through the physical channel of the main cell is determined according to whether the sub-cell exists.

14. A method for determining a paging alert mode in a mobile communication system, comprising the steps of:

inserting, in a main BSC, sub-cell information for a sub-cell and a beacon paging period in a broadcasting channel message and transmitting the broadcasting channel message, when the sub-cell exists in a main cell formed by the main BSC;

upon receipt of a paging request from a core network, transmitting, in a radio network controller, paging request information with a paging group frame to which a paging-requested mobile terminal belongs, out of paging group frames in a super frame; and

transmitting, in a sub-BSC for forming the sub-cell, a beacon paging group frame requesting a change of the paging alert mode.

15. The method as claimed in claim 14, wherein the broadcasting channel message transmitting step comprises the steps of:

determining whether there exists the sub-BSC for forming the sub-cell in the main cell formed by the main BSC;

designating, in the main BSC, a beacon paging group frame for the sub-cell, when the sub-BSC exists;

determining a beacon paging period at which the beacon paging group frame is to be transmitted;

generating a broadcasting channel message including the sub-cell information with an ID designating the beacon paging group frame and the determined beacon paging period; and

transmitting the generated broadcasting channel message to every mobile terminal located in the main cell through a broadcasting channel.

16. The method as claimed in claim 14, wherein the paging request information transmitting step comprises the steps of:

monitoring a paging request from the core network;

upon receipt of the paging request, determining whether there exists the sub-BSC;

determining, when the sub-BSC exists, a paging group depending on the number of the paging group frames in the super frame excepting the designated beacon paging group frame and an ID of the mobile terminal to be paged;

determining, when the sub-BSC does not exist, a paging group depending on the number of the paging group frames in the super frame and the ID of the mobile terminal to be paged; and

transmitting paging request information with the paging group frame corresponding to the determined paging group through a physical channel.

17. The method as claimed in claim 14, wherein the beacon paging group frame transmitting step comprises the steps of:

detecting an interrupt provided from the radio network controller at a transmission time point of the beacon paging group frame; and

upon detecting the interrupt, transmitting, in the sub-BSC, a beacon paging group frame in which all bit values for requesting a change of the paging alert mode are '1', through the physical channel.

18. The method as claimed in claim 15, wherein the beacon paging period is determined as a multiple of a period of the super frame.

19. An apparatus for determining a paging alert mode in a mobile communication system, comprising:

a main BSC for forming a main cell, and inserting, when there exists a sub-cell in the main cell, sub-cell information for the sub-cell and a beacon paging period in a broadcasting channel message before transmission;

a radio network controller for transmitting paging request information with the paging group frame to which a paging-requested mobile terminal belongs, out of the paging group frames in the super frame;

a sub-BSC for forming the sub-cell, and transmitting a beacon paging group frame requesting a change of the paging alert mode in response to an interrupt from the radio network controller; and

a mobile terminal for setting the paging alert mode according to whether the beacon paging group frame is accessed, and performing the set paging alert mode when paging is detected by accessing the paging group frame.